CLAIMS

1. An exposure apparatus having:

an irradiation means for irradiating a pattern formed on a mask with an exposing energy having a wavelength of 250 nm or less; and

a projection optical system for projecting an image of the pattern of the mask at a predetermined position on a substrate; characterized by

a reflecting member, disposed at least a portion in a Fourier transform plane formed between an object plane and an image plane of the projection optical system or in a plane in the vicinity thereof, having reflecting properties relative to the exposing energy incident from an object plane side of the projection optical system or the exposing energy incident from an image plane side of the projection optical system;

wherein an exposing condition for the substrate is set on the basis of intensity of a reflected energy reflected from the reflecting member, in order to reduce deterioration in precision for controlling an exposure amount resulting from a variation in an attenuation factor of the projection optical system.

2. An exposure apparatus having:

an irradiation means for irradiating a pattern formed on a mask with an exposing energy having a wavelength of 250 nm or less; and

a projection optical system for projecting an image of the pattern of the mask at a predetermined position on a

substrate; characterized by

a reflecting member, disposed at least a portion in a Fourier transform plane formed between an object plane and an image plane of the projection optical system or in a plane in the vicinity thereof, having reflecting properties relative to the exposing energy incident from an object plane side of the projection optical system or the exposing energy incident from an image plane side of the projection optical system;

a beams irradiation means which irradiate measuring beams in a state that the exposing energy is nearly collimated, toward the reflecting member from an object plane side or an image plane side of the projection optical system;

a detection means which detect an energy reflected by the reflecting member and output a detection signal in accordance with the reflected energy; and

an exposure control means which set an exposing condition for the substrate on the basis of the detection signal from the detection means, in order to reduce deterioration in precision for controlling an exposure amount resulting from a variation in an attenuation factor of the projection optical system.

3. The exposure apparatus as claimed in claim 2, wherein the reflecting member is disposed at a generally central portion, a peripheral portion or at an entire area in the Fourier transform plane of the projection optical system or in the plane in the vicinity thereof.

4. The exposure apparatus as claimed in claim 3, wherein the irradiation means comprises a pulse laser light source which radiates ultraviolet pulse light having a wavelength of 200 nm or less as the exposing energy, and an exposing illumination system which irradiates the ultraviolet pulse light toward a predetermined illumination region set on the mask; and the beam irradiation means comprises a beam generating optical system which generates the measuring beams based on the ultraviolet pulse light from the pulse laser light source.

5. The exposure apparatus as claimed in claim 4, wherein the beam generating optical system is disposed on the object plane side of the projection optical system and the detection means, which detect the reflected energy, is disposed on the object plane side of the projection optical system.

6. The exposure apparatus as claimed in claim 4, wherein the beams generating optical system is disposed on the image plane side of the projection optical system and the detection means is disposed on the image plane side of the projection optical system.

7. The exposure apparatus as claimed in claim 3, wherein the reflecting member has a reflecting plane for deflecting the reflected energy from a projection light path in the projection optical system, and the detection means is disposed outside the projection light path.

8. The exposure apparatus as claimed in claim 3, further comprising a movable mechanism for supporting the reflecting

member so as to enter the reflecting member in the Fourier transform plane of the projection optical system or in the plane in the vicinity thereof, or evacuate it therefrom, wherein the reflecting member enters a projection light path when the measuring beams are irradiated into the projection optical system and is evacuated therefrom when the pattern of the mask is projected and exposed to the substrate.

9. The exposure apparatus as claimed in claim 2, wherein the projection optical system is of a catadioptric type in which a refractive optical element is combined with a reflective optical element.

10. A method for scanning and exposing an entire image of a pattern of a mask to a substrate being exposed,

which is carried out by:

irradiating a portion of the pattern of the mask with an exposing energy having a wavelength of 250 nm or less; and

scanning the mask and the substrate relative to a vision field of the projection optical system, while projecting a partial image of the pattern thereof onto the substrate through a projection optical system;

characterized by the steps of:

irradiating the exposing energy onto a reflecting member prior to starting the scanning exposure, the reflecting member being disposed at least at a portion in a Fourier transform plane formed between an object plane and an image plane of the projection optical system or in a plane in the vicinity thereof, and detecting intensity of a

reflected energy reflected from the reflecting member; and

setting an exposing condition for transcribing the entire image of the pattern thereof onto the exposing substrate at a predetermined exposure amount in accordance with the intensity detected.

11. The exposure method as claimed in claim 10, wherein the exposing energy to be irradiated on the reflecting member passes through the object plane side or the image plane side of the projection optical system in a substantially collimated state and is substantially converged on the reflecting member.

12. The exposure method as claimed in claim 11, wherein during the scanning and exposing, when the mask is transferred to at least one of a position at which the scanning of the mask relative to a vision field of the projection optical system is started or a position at which the scanning of the mask relative to the vision field thereof is terminated, the exposure energy is shaped into measuring beams being generally parallel to each other and irradiated onto the reflecting member from the object plane side or the image plane side of the projection optical system, and then the intensity of the reflected energy reflected from the reflecting member is detected.

13. The exposure method as claimed in claim 12, wherein when the exposing condition is set, at least one of an illuminance of the exposing energy to be irradiated on the mask during the scanning and exposing, a width of the energy in the scanning direction to be irradiated on the mask, and

a velocity for scanning the mask and the substrate during the scanning and exposing is adjusted on the basis of a result of detection of the intensity of the exposing energy to be irradiated on the mask for scanning exposure, a result of detection of the intensity of the reflected energy which is reflected by the reflecting member by irradiation of the measuring beams and a target exposure amount to be provided on the substrate.

14. The exposure method as claimed in claim 12, wherein the reflecting member is formed at a portion of a refractive optical element or a reflective optical element located in the Fourier transform plane of the projection optical system or in the plane in the vicinity thereof.

15. The exposure apparatus as claimed in claim 10, wherein the projection optical system is of a catadioptric type in which the refractive optical element and the reflective optical element are combined with each other.

16. A manufacturing method for forming a circuit device on a substrate,

which is carried out by a lithographic process comprising;

irradiating a circuit pattern formed on a mask with an exposing energy; and

exposing the circuit pattern thereof to each of plural positions on the substrate sequentially through a projection optical system;

characterized by the steps of:

detecting an intensity of the exposing energy passing

through a projection light path, including a portion of a variation in an attenuation factor of the projection optical system, through a reflecting member disposed at least at a portion in a Fourier transform plane formed in the projection light path of the projection optical system or in a plane in the vicinity thereof; and

setting an exposing condition for exposing the substrate at a target exposure amount in accordance with the intensity of the exposing energy detected, in order to reduce deterioration in precision for controlling the exposure amount resulting from the variation in the attenuation factor of the projection optical system.

17. The manufacturing method for forming the circuit device as claimed in claim 16, wherein the reflecting member is formed at a portion of a refractive optical element or a reflective optical element located in the Fourier transform plane of the projection optical system or in the plane in the vicinity thereof.

18. The manufacturing method for forming the circuit device as claimed in claim 17, wherein during the step for setting the exposing condition, at least one of an illuminance of the exposing energy to be irradiated on the mask and a period of time for continuing irradiation of the exposing energy on the mask is adjusted on the basis of a result of detection of the intensity of the exposing energy to be irradiated on the mask, a result of detection of the intensity of the reflected energy which is reflected at the reflecting member, and the target exposure amount to be

provided on the substrate.

19. The method as claimed in claim 16, wherein the reflecting member has an area covering a substantially whole area of the Fourier transform plane in the projection optical system,

and wherein during the step for detecting the intensity of the exposing energy passing through the projection light path, the projection optical system is irradiated by the exposing energy from an exposing illumination system for exposing a pattern of the mask to the substrate, and the reflected energy reflected from the reflecting member covering the substantially whole area of the Fourier transform plane is detected.

20. The method as claimed in claim 16, wherein the reflective optical element is also used as the reflecting member when the projection optical system is composed of a catadioptric type having the reflective optical element disposed in the vicinity of the Fourier transform plane.

21. An exposure apparatus having:

an illumination optical system for irradiating a pattern formed on a mask with an exposing energy having a wavelength of 250 nm or less; and

a projection optical system for projecting an image of the pattern of the mask at a predetermined position on a substrate; characterized by

a reflecting member, disposed at least at a portion in a Fourier transform plane formed between an object plane and an image plane of the projection optical system or in a

plane in the vicinity thereof, for reflecting exposing energy incident from the object plane side of the projection optical system through the illumination optical system;

wherein an exposing condition for exposing the substrate is set on the basis of the intensity of the reflected energy reflected from the reflecting member, in order to reduce a deterioration in precision for controlling the exposure amount resulting from a variation in an attenuation factor of the illumination optical system and the projection optical system.

22. An exposure apparatus having:

an illumination optical system for irradiating a pattern formed on a mask with an exposing energy having a wavelength of 250 nm or less; and

a projection optical system for projecting an image of the pattern of the mask at a predetermined position on a substrate; characterized by

a reflecting member, disposed at least at a portion in a Fourier transform plane formed between an object plane and an image plane of the projection optical system or in a plane in the vicinity thereof, having reflecting properties relative to the exposing energy incident from the object plane side of the projection optical system through the illumination optical system;

a beam irradiation means which irradiates the exposing energy as measuring beams in a substantially collimated state toward the reflecting member from the object plane side of each of the illumination optical system and the

projection optical system;

a detection means which detects the reflected energy reflected by the reflecting member and returning through the illumination optical system and which output a detection signal in accordance with the reflected energy; and

an exposure control means which sets an exposing condition for exposing the substrate based on the detection signal from the detection means, in order to reduce a deterioration in precision for controlling the exposure amount resulting from a variation in an attenuation factor of the illumination optical system and the projection optical system.

23. A projection exposure apparatus having:

an illumination optical system for irradiating a pattern formed on a mask with an exposing energy having a wavelength in an ultraviolet range; and

a projection optical system for projecting an image of the pattern of the mask at a predetermined position on a substrate; characterized by

a first detection means, disposed in a vision field of the projection optical system outside an image projection region in which an image of the pattern of the mask is projected, which receives at least a portion of the exposing energy passing through the projection optical system and travelling toward the substrate and output a detection signal in accordance with an intensity of the exposing energy received;

a second detection means which detects an intensity of

the exposing energy in a predetermined position in a light path extending from a light source disposed in the illumination optical system to the mask and which output a detection signal in accordance with the intensity of the exposing energy detected;

a variation detection means which detects a variation in an attenuation factor with respect to the exposing energy, which occurs in a light path of the irradiation means or in a light path of the projection optical system; and

an exposure control means which corrects an exposing condition for exposing the substrate so as to provide the substrate with a desired exposure amount, when such a variation in the attenuation factor is detected by the variation detection means.

24. The projection exposure apparatus as claimed in claim 23, wherein the first detection means further comprises a reflecting member disposed at a top end on the image plane side of the projection optical system and outside the image projection region; and a photoelectric element for photoelectrically detecting a portion of the exposing energy reflected with the reflecting member.

25. The projection exposure apparatus as claimed in claim 24, wherein the reflecting member is composed of a full reflection mirror plane so as to block an arrival at the substrate of the exposing energy passed through outside of the image projection region.

26. The projection exposure apparatus as claimed in claim 23, wherein the exposure control means is to correct at

least one of an intensity of the exposing energy emitting from the light source, an attenuation factor of an attenuator disposed in the irradiation means, and an irradiation time for irradiating the exposing energy to the substrate, in accordance with the variation in the attenuation factor detected.

27. The projection exposure apparatus as claimed in claim 23, wherein the light source comprises an ultraviolet laser light source for radiating a light in a wavelength width set so as to avoid an absorption band of oxygen in a wavelength region shorter than 250 nm.

28. The projection exposure apparatus as claimed in claim 23, further comprising: a movable stage mechanism for moving in a plane parallel to the image plane of the projection optical system in a state in which the substrate is loaded thereon; and a third detection means, disposed in the movable mechanism, for detecting an illuminance of the exposing energy obtained in an image projection region on the image plane side of the projection optical system; wherein the exposure control means is to correct the exposing condition on the basis of a result of detection by the variation detection means and the third detection means.

29. The projection exposure apparatus as claimed in claim 23, wherein the variation detection means further comprises an operation processing circuit for sequentially saving data corresponding to a ratio of each detection signal by the first detection means to each detection signal by the second detection means at every predetermined time and for

computing a periodical change rate of the variation in the attenuation factor on the basis of the data saved.

30. The projection exposure apparatus as claimed in claim 23, wherein the variation detection means further comprises a fourth detection means disposed in a space between the projection optical system and the substrate so as to enter in an image pattern region in a vision field of the projection optical system or to be evacuated therefrom; and the variation in the attenuation factor is detected by irradiating a transparent portion around a pattern region of the mask with the exposing energy and photoelectrically detecting the light passed through the transparent portion of the mask, when the fourth detection means is inserted into the image projection region.

31. The projection exposure apparatus as claimed in claim 30, wherein the exposure control means is to calibrate a detection signal corresponding to the variation in the attenuation factor to be detected by the first detection means on the basis of a signal detected by the fourth detection means.

32. A projection exposure apparatus for scanning an entire image of a pattern of a mask and exposing the entire pattern thereof onto a substrate by scanning the mask and the substrate relative to a vision field of a projection optical system,

the apparatus having:

an irradiation means for irradiating an exposing energy having an ultraviolet wavelength range, a projection

optical system for projecting an partial image of the pattern formed on the mask by irradiating a portion of the pattern to be formed on the mask with the exposing energy from the irradiation means; and

a scanning mechanism for scanning the mask and the substrate relative to the vision field of the projection optical system; characterized by

a restriction means which restricts an image projection region, in which a partial image of the pattern of the mask is projected, to a polygonal or arc-shaped region extending in a direction intersecting with a relative scanning direction in a vision field of the projection optical system;

a detection means, disposed in a region outside the image projection region relating to the relatively scanning direction in the vision field of the projection optical system, which receives at least a portion of the exposing energy passed through the projection optical system and travelling toward the substrate and outputs a detection signal in accordance with the intensity of the energy; and

an exposure control means which sets an exposing condition for transcribing the entire image of the pattern thereof on the substrate at a predetermined exposure amount on the basis of the detection signal and for controlling scanning exposure in accordance with the exposing condition.

33. The projection exposure apparatus as claimed in claim 32, wherein the restriction means is provided with an illumination vision field stop which is disposed in a

position substantially conjugated with the mask in a light path of the irradiation means and which has a linearly slit-shaped or rectangular opening extending in a direction intersecting with a direction of the relative scanning.

34. The projection exposure apparatus as claimed in claim 33, wherein the detection means further comprises a reflecting member disposed between the projection optical system and the substrate and a photoelectric element for receiving a portion of the exposing energy reflected by the reflecting member, wherein the reflecting member is disposed in a region within the vision field of the projection optical system and outside the image projection region relating to the relative scanning.

35. The projection exposure apparatus as claimed in claim 34, wherein the exposing energy to be detected by the photoelectric element through the reflecting member passes through a small opening portion formed at a portion of the illumination vision field stop and irradiates through the irradiation means, the transparent portion around the pattern region of the mask, and the projection optical system.

36. The projection exposure apparatus as claimed in claim 34, wherein the detection means is to detect the exposing energy through the reflecting member while the mask is located at an approach run start position for relatively scanning each of plural shot regions when the scanning mechanism scans the mask and the substrate relative to each of the plural shot regions on the substrate.

37. A method for scanning and exposing an entire image of a pattern of a mask to a substrate being exposed,

which is carried out by:

irradiating a portion of the pattern of the mask with an exposing energy of an ultraviolet region having a wavelength of 250 nm or less; and

scanning the mask and the exposing substrate relative to a vision field of a projection optical system, while projecting a partial image of the pattern thereof onto the substrate through the projection optical system;

characterized by the steps of:

restricting an image projection region in which the partial image of the pattern thereof is projected to a polygonal or arc-shaped region extending in a direction intersecting with a relative scanning direction in the vision field of the projection optical system upon scanning exposure;

detecting an intensity of at least a portion of the exposing energy passing through a region outside the image projection region relating to the relative scanning direction in the vision field of the projection optical system, at the time of starting the scanning exposure; and

setting an exposing condition for transcribing the entire image of the pattern thereof on the substrate at a predetermined exposure amount on the basis of the intensity of the exposing energy detected, before starting the scanning and exposing.

38. The exposure method as claimed in claim 37, wherein a

result of detection of the exposing energy passing through the region outside the image projection region relating to the relative scanning in the vision field of the projection optical system is calibrated on the basis of an illuminance of the exposing energy measured in advance in the image projection region, when the exposing condition is set.

39. The exposure method as claimed in claim 37, wherein, when the exposing energy which passes through the region outside the image projection region relating to the relative scanning direction in the vision field of the projection optical system is detected, the intensity of the exposing energy is detected individually in each of the plural positions outside the image projection region, and an irregularity of an attenuation factor in a light path through which the exposing energy passed is measured on the basis of the result of detection.

40. The exposure method as claimed in claim 37, wherein the exposing energy comprises pulse light from a narrow-banded ArF excimer laser light source so as to avoid an absorption band of oxygen.

41. The exposure method as claimed in claim 40, wherein, when the exposing energy which passes through the region outside the image projection region relating to the relatively scanning direction in the vision field of the projection optical system is detected, a peripheral transparent portion around the pattern region on the mask is located in the vision field on the object side of the projection optical system and outside the image projection

region, and the exposing energy is detected through the peripheral transparent portion of the mask.

42. A manufacturing method for forming a circuit device on a substrate,

which is carried out by a lithographic process for projecting and exposing a circuit pattern formed on a mask to be irradiated with an exposing energy of an ultraviolet region having a wavelength of 250 nm or less to each of plural positions on a substrate through a projection optical system; characterized by the steps of:

detecting a variation in an intensity of the exposing energy resulting from a variation in an attenuation factor of the projection optical system by detecting at least a portion of the exposing energy passed through an outer region of an image projection region in a vision field of the projection optical system and travelling toward the substrate side at a position close to an image plane of the projection optical system, the image projection region being a region in which an image of the circuit pattern of the mask is formed; and

setting an exposing condition for transcribing the circuit pattern onto the substrate at a predetermined exposure amount on the basis of the variation in the intensity of the exposing energy detected;

wherein a deterioration in precision for controlling the exposure amount due to the variation in the attenuation factor of the projection optical system is reduced, and the variation in the attenuation factor occurs when the image of

the circuit pattern is projected and exposed sequentially onto the substrate.

43. The manufacturing method for forming the circuit device as claimed in claim 42, wherein a first detector is disposed at a top end portion on the image side of the projection optical system in order to detect a variation in the intensity of the exposing energy resulting from the variation in the attenuation factor of the projection optical system.

44. The manufacturing method for forming the circuit device as claimed in claim 43, wherein a second detector for detecting the intensity of at least a portion of the exposing energy passing through the image projection region is disposed on a movable stage for holding the substrate thereon and for transferring the substrate in a two-dimensional way; and a result of detection by the first detector is calibrated on the basis of a result of detection by the second detector.

45. The manufacturing method for forming the circuit device as claimed in claim 43 or 44, wherein the exposing energy is irradiated on a peripheral portion outside the circuit pattern region of the mask and the exposing energy passed through the peripheral portion the projection optical system is detected, upon detecting the exposing energy by the first detector or the second detector.

46. A projection exposure apparatus for transcribing a transcribing pattern on a mask onto a photosensitive substrate by irradiating the transcribing pattern on the

mask with illumination light of an ultraviolet wavelength region and projecting the transcribing pattern on the mask onto the photosensitive substrate through a projection optical system; comprising:

a sensor for measuring a variation in an attenuation factor of the projection optical system resulting from irradiation with the illumination light of a ultraviolet wavelength region; and

a control unit for maintaining an illuminance of the illumination light on the photosensitive substrate at a substantially constant level during exposure on the basis of an output of the sensor.

47. The projection exposure apparatus as claimed in claim 46, wherein the sensor receives at least a portion of the reflected light reflected from the photosensitive substrate.

48. The projection exposure apparatus as claimed in claim 46, further comprising a light receipt element for receiving a portion of the illumination light incident to the mask, and the control unit uses an output of each of the sensor and the light receipt element.

49. The projection exposure apparatus as claimed in claim 46, wherein the illuminance of the illumination light on the photosensitive substrate comprises at least an average illuminance in the exposure region of the projection optical system or an irregularity of illuminance in the exposure region of the projection optical system.

50. The projection exposure apparatus as claimed in claim 46, further comprising a drive unit for transferring the

mask and the photosensitive substrate in synchronization with each other relatively to the projection optical system.

51. The projection exposure apparatus as claimed in claim 50, wherein the projection optical system comprises an equal-magnification optical system having a first object section and a light axis turn section with a concave mirror installed therein, and a reduced projection system having a light axis deflection section and a second object section.

52. A projection exposure apparatus for transcribing a transcribing pattern on a mask onto a photosensitive substrate sequentially by irradiating the transcribing pattern on the mask with illumination light of an ultraviolet wavelength region and projecting the transcribing pattern on the mask onto the photosensitive substrate through a projection optical system; comprising:

a sensor for detecting a variation in an imaging characteristic of the projection optical system on the basis of a variation in an attenuation factor of the projection optical system resulting from irradiation with the illumination light of the ultraviolet wavelength region; and

a control unit for controlling the imaging characteristic on the basis of an output of the sensor.

53. A projection exposure apparatus for transcribing a transcribing pattern on a mask onto a photosensitive substrate subsequently by irradiating the transcribing pattern on the mask with illumination light of an ultraviolet wavelength region and transferring the mask and the photosensitive substrate in synchronization with a

projection optical system relatively to a projection optical system; comprising:

an adjustment device for adjusting at least one of an intensity of the illumination light on the photosensitive substrate, a velocity for scanning the photosensitive substrate, and a width of an illumination region of the illumination light relating to a scanning direction of the photosensitive substrate, on the basis of a variation in an attenuation factor of the projection optical system resulting from irradiation with the illumination light of the ultraviolet wavelength region.

54. The projection exposure apparatus as claimed in claim 53, wherein the illumination light of the ultraviolet wavelength region is pulse light; and the adjustment device adjusts at least one of a frequency of oscillation of the pulse light, the intensity of the illumination light, the velocity for scanning the photosensitive substrate, and the width of the illumination region.

55. The projection exposure apparatus as claimed in claim 53, wherein the projection optical system comprises an equal-magnification optical system having a first object section and a light axis turn section with a concave mirror installed therein, and a reduced projection system having a light axis deflection section and a second object section.

56. A manufacturing method for manufacturing a micro device, including a photolithography process for irradiating a device pattern with an illumination light of an ultraviolet wavelength region and exposing an image of the

device pattern to a substrate, characterized by the step of:

detecting at least one of an illuminance of the illumination light on the substrate, an irregularity of illuminance, and an image characteristic of the device pattern, on the basis of a variation in an attenuation factor resulting from irradiation of the illumination light of the ultraviolet wavelength region, during the exposure.

57. An exposure method for irradiating a mask with an illumination light through an illumination optical system and exposing a photosensitive substrate to the illumination light through a projection optical system; characterized by the steps of:

supplying gas having less absorption of the illumination light at least a portion of the illumination optical system and the projection optical system; and

changing an exposing condition for the photosensitive substrate in accordance with a variation in transmittance or in reflectance of at least one of the illumination optical system and the projection optical system, resulting from irradiation of the illumination light.

58. The exposure method as claimed in claim 57, wherein an image characteristic of the pattern on the mask is further adjusted in accordance with a variation in an imaging characteristic of the projection optical system attendant upon the variation in transmittance or reflectance.

59. A projection exposure apparatus for irradiating a mask with an illumination light through an illumination optical system and exposing a photosensitive substrate to the

illumination light; comprising:

a projection optical system disposed between the mask and the photosensitive substrate, which is filled with gas having less absorption of the illumination light; and

an adjustment device for adjusting an exposing condition of the photosensitive substrate in accordance with a variation in transmittance or in reflectance of the projection optical system resulting from irradiation with the illumination light.